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TRENDS OF MOUNTAIN PINE BEETLE OUTBREAKS IN MIXED STANDS OF PREFERRED HOSTS

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INTRODUCTION

The mountain pine beetle, Dendroctonus ponderosae Hopkins, is considered the most destructive forest insect in the Intermountain Region. During the past 20 years, massive outbreaks have occurred throughout much of the lodgepole pine (Pinus contorta Dougl.) type in northern Utah, southeastern Idaho, and western Wyoming. Less extensive infestations, though not necessarily unimportant, have occurred in stands of ponderosa pine (P. ponderosa Laws.), limber pine (P. flexilis James), whitebark pine (P. albicaulis Engelm.), pinyon pine (P. edulis Engelm.), and singleleaf pinyon (P. monophylla T. & F.). S. L. Wood (1963) listed the following pines as hosts in other portions of the West: foxtail pine (P. balfouriana Grev. & Balf.), Coulter pine (P. coulteri D. Don), Jeffrey pine (P. jeffreyi Grev. & Balf.), sugar pine (P. lambertiana Dougl.), western white pine (P. monticola Dougl.), and southwestern white pine (P. strobiformis Engelm.). Further, the mountain pine beetle has been known to attack Engelmann spruce (Picea engelmannii Parry) during epidemics.

Forest entomologists sometimes disagree concerning the host selection behavior of this beetle in mixed stands of preferred hosts. Some believe that this beetle displays host specificity for the tree species in which it developed, while others feel that all susceptible hosts can be attacked, depending on favorable conditions, regardless of the host in which the population completed development. Generally, there is little proof, other than circumstantial evidence, to support either view. The main reason for the uncertainty is based on the fact that investigators have been unable to show that the population they tested completed development in one or more hosts.

BACKGROUND

The "Host-Selection Principle," as proposed by Hopkins (1917), was extensively reviewed by D. L. Wood (1963). The "Principle" evolved from investigations of methods of controlling mountain pine beetle outbreaks. Hopkins (1917) stated the following: "...the mountain pine beetle (Dendroctonus monticolae Hopk.) will attack and kill the mountain pine (= whitebark pine), yellow pine (= ponderosa pine), lodgepole pine, and sugar pine, but that if it becomes established in one host species, as, for example, the lodgepole pine, through continuous attack of many generations, the beetles--when they emerge--will not attack nearby trees of any other host species but will show a decided preference for the species in which they bred." Hopkins was apparently unaware that Walsh[1/] had proposed essentially the same idea many years previous (Craighead, 1923).

1/ Walsh, B. D. 1864. On phytophagic varieties and phytophagous species. Proc. Entomol. Soc. Philadelphia. 3:403-430.

The results of several investigations of the host selection behavior of the mountain pine beetle have not confirmed Hopkins' "Host Selection Principle." Keen (1916) found that D. ponderosae adults will attack ponderosa or sugar pine regardless of their origin from these two species, but sugar pine was preferred. Richmond (1933), in testing preference for ponderosa pine and lodgepole pine, determined that there was a decided preference for ponderosa pine, even though test insects completed development in both species. Cage control experiments conducted by Struble (1935), using freshly cut logs of sugar pine, lodgepole pine, ponderosa pine, and Jeffrey pine, failed to show any decided preference between the four species tested. Furniss and Schenk (1969) reported that seven exotic hosts--jack pine (P. banksiana Lamb.), Austrian pine (P. nigra Arnold), red pine (P. resinosa Ait.), pitch pine (P. rigida Mill.), eastern white pine (P. strobus L.), scotch pine (P. sylvestris L.), and Norway spruce (Picea abies (L.))--were attacked by a native population of D. ponderosae at the Shattuck Arboretum at the University of Idaho, while ponderosa pine and western white pine were not attacked.

Even though there are numerous reports of the mountain pine beetle displaying host specificity (S. L. Wood, 1963), there is little data to support Hopkins' "Principle." Baker, et al (1971), suggested that D. ponderosae brood developing in lodgepole pine or whitebark pine preferred to infest the same host. Their conclusion was based on differences in the level of tree mortality between these species recorded during stand cruises on the Teton and Bridger National Forests in western Wyoming. No additional sources, which included data on host specificity, were located.

OBJECTIVE

The objective of this report is to document aerial reconnaissance and stand inventory data, which are relevant to the host selection behavior of the mountain pine beetle. Some of the information provided in this report was collected in near proximity and during the same time period as that reported by Baker and others (1971). Once again, the evidence is circumstantial, but it adds to previously reported information.

RESULTS AND DISCUSSION

Aerial Surveillance Records. Extensive aerial survey data collected in the Intermountain Region indicate that the mountain pine beetle does not display host specificity in mixed stands of preferred hosts. Two examples will be provided showing the yearly trends of outbreaks in areas where two hosts were attacked and killed. Similar trends have been observed in other portions of the Region. No attempt will be made to assess the factors that could influence the host selection behavior of the mountain pine beetle.

The mountain pine beetle outbreak on the Teton National Forest and in Grand Teton National Park in Wyoming originated in low elevation lodgepole pine stands in 1955, intensified, and spread into stands at higher elevations. By 1967, much of the lodgepole pine type on the Forest was infested, even though nearby stands of whitebark pine and limber pine were relatively free of beetle-killed trees. However, the extent of mortality in the soft pines increased from 1968 to 1972, while the level of lodgepole pine mortality decreased (Figures 1 and 2, Appendix). It is assumed that the beetle population, which developed in lodgepole pine for several generations, apparently infested the other host species. This same general trend also has been observed on the Targhee, Bridger, and Caribou National Forests during recent outbreaks.

As a second example, an outbreak in mixed stands of ponderosa pine and lodgepole pine in the Greendale Junction area of the Ashley National Forest also was aerially mapped for several successive years. As shown in Figure 3 (Appendix), the infestation started in both hosts and continued in succeeding years. Even though there is no evidence to show that beetles emerging from one host attacked the other, both hosts were obviously susceptible at the same period of time and could have been killed by the same beetle population. Further, there did not appear to be a decided difference in the rate of mortality for either host species.

Stand Inventories: Data collected during annual mortality trend surveys confirm aerial surveillance information in regard to the host selection behavior of D. ponderosae. For example, the mortality by occurrence of lodgepole pine and limber pine were approximately equal, 10.3 and 12 percent, respectively, in a 400-acre area on the Bridger National Forest (Stipe, 1972). During the 6 years that data were collected in this area, no preference for either host was detected. A similar trend study conducted in Yellowstone National Park produced mortality estimates of 2.1 percent for whitebark pine and 3.7 percent for lodgepole pine (Parker, 1972). The outbreaks in the above-mentioned examples originated in lodgepole pine, intensified, spread into mixed stands, and killed the various preferred hosts at about equal rates.

CONCLUSIONS

The factors that influence the host selection behavior of D. ponderosae are unknown, but preferences could result from competition to occupy the same ecological niche, from differences in the susceptibility of host species, from climatic conditions, from genetic differences of local populations, or from a multiplicity of other factors. Nevertheless, the information provided in this report, as well as that from most other sources, indicate to the land manager that he cannot rely on the premise that the mountain pine beetle only breeds in one host species in a mixed stand of preferred hosts.

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APPENDIX

Figure 1. Aerial photograph shows whitebark pine mortality along the slopes of Mt. Moran, Grand Teton National Park. The mountain pine beetle outbreak started in low elevation lodgepole pine stands and apparently moved into the whitebark stand in subsequent years.

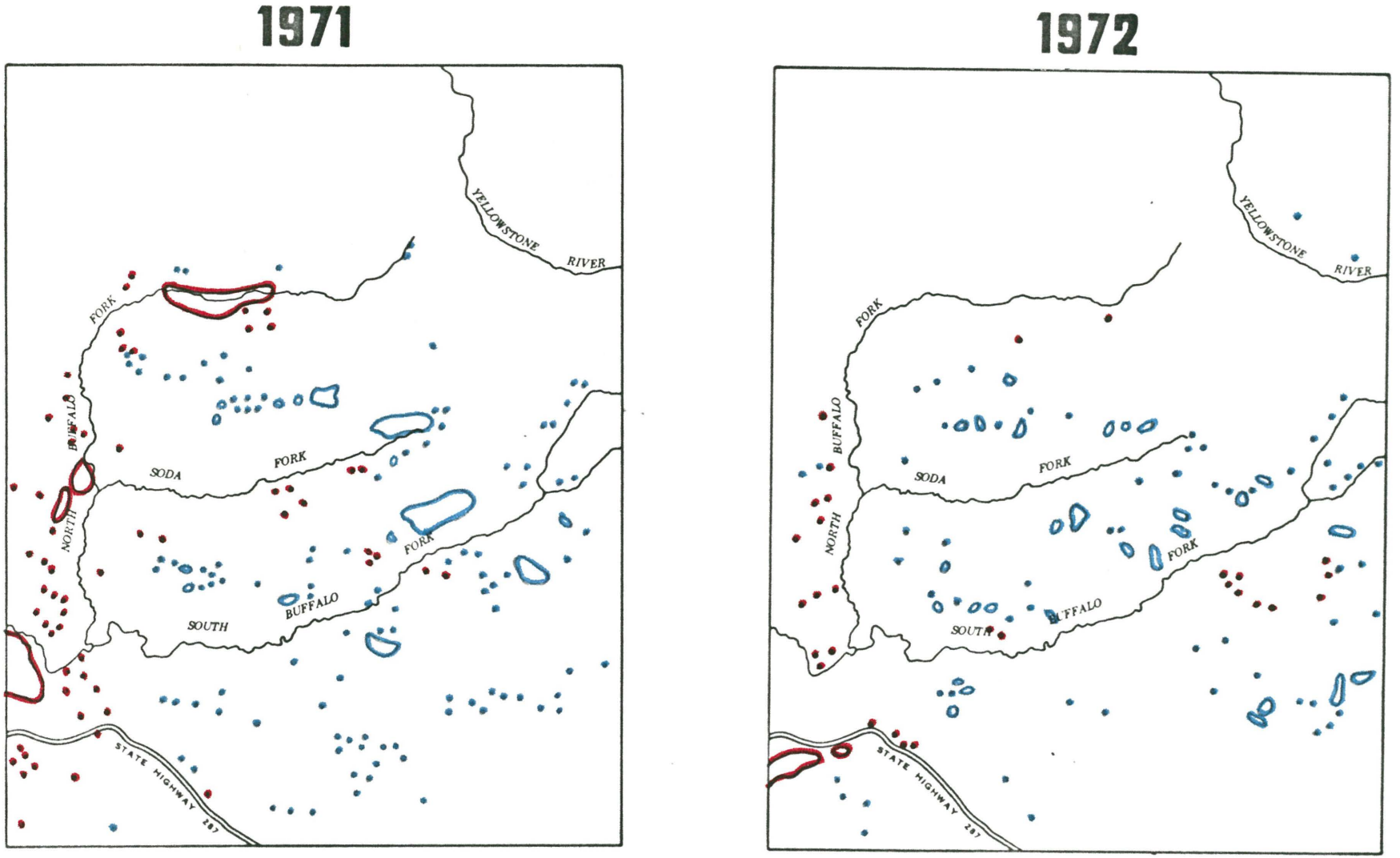
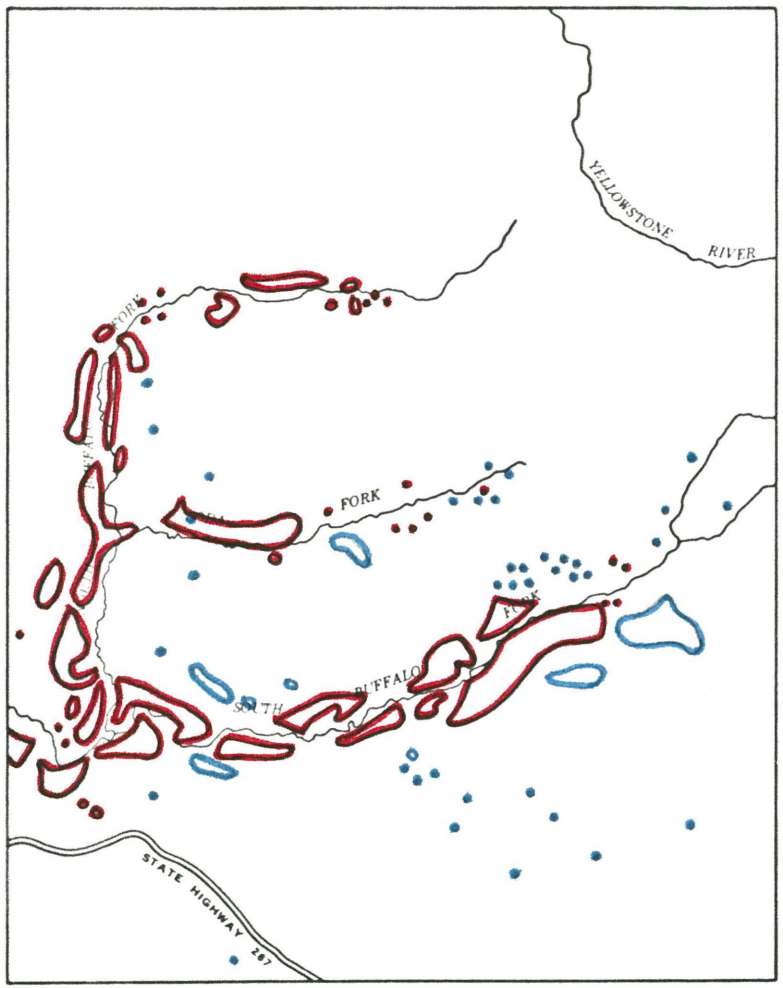
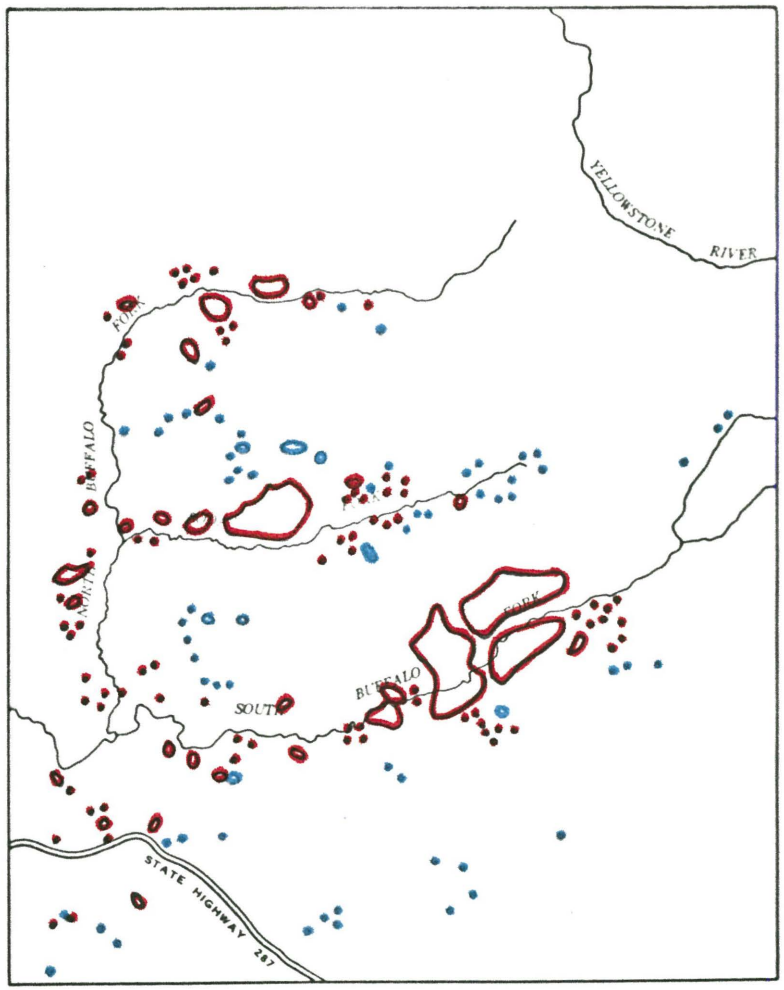


Figure 2. Yearly aerial survey maps of the upper drainages of the Buffalo River, Teton National Forest, showing the extent of lodgepole pine (red) and whitebark pine (blue) mortality casued by *D. ponderosae*. Scale: 1 inch = 4 miles.

1969


YELLOWSTONE RIVER
FORK
SOUTH BUFFALO FORK
STATE HIGHWAY 287

1970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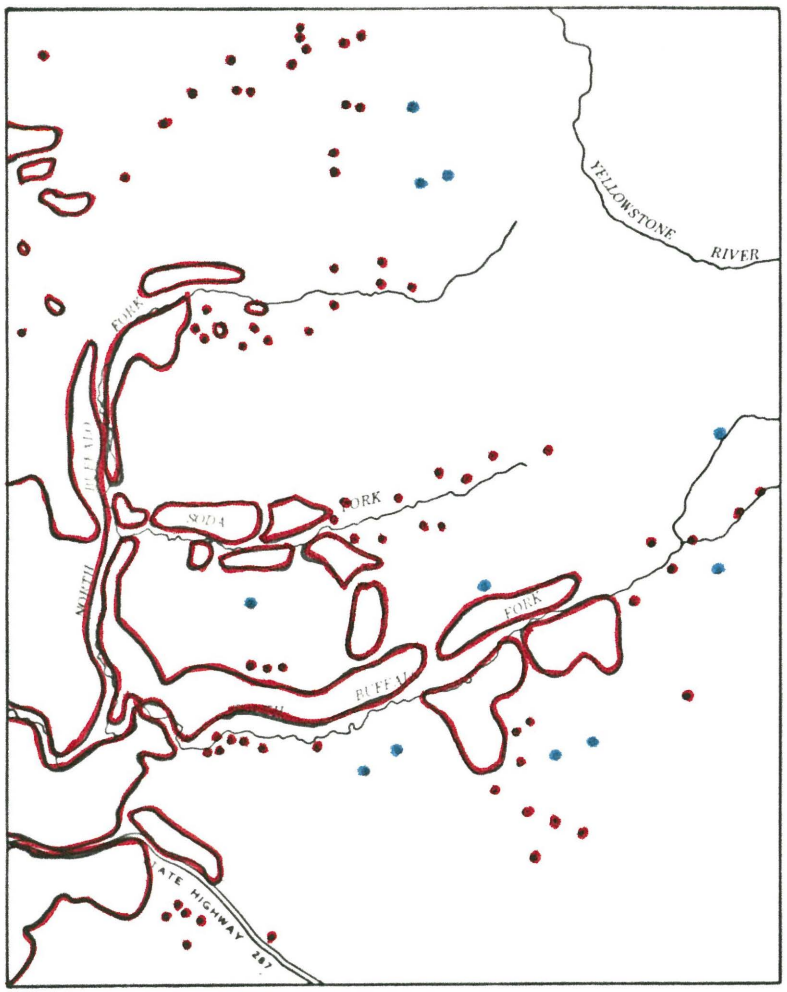
FORK
BUFFALO
STATE HIGHWAY 287

1967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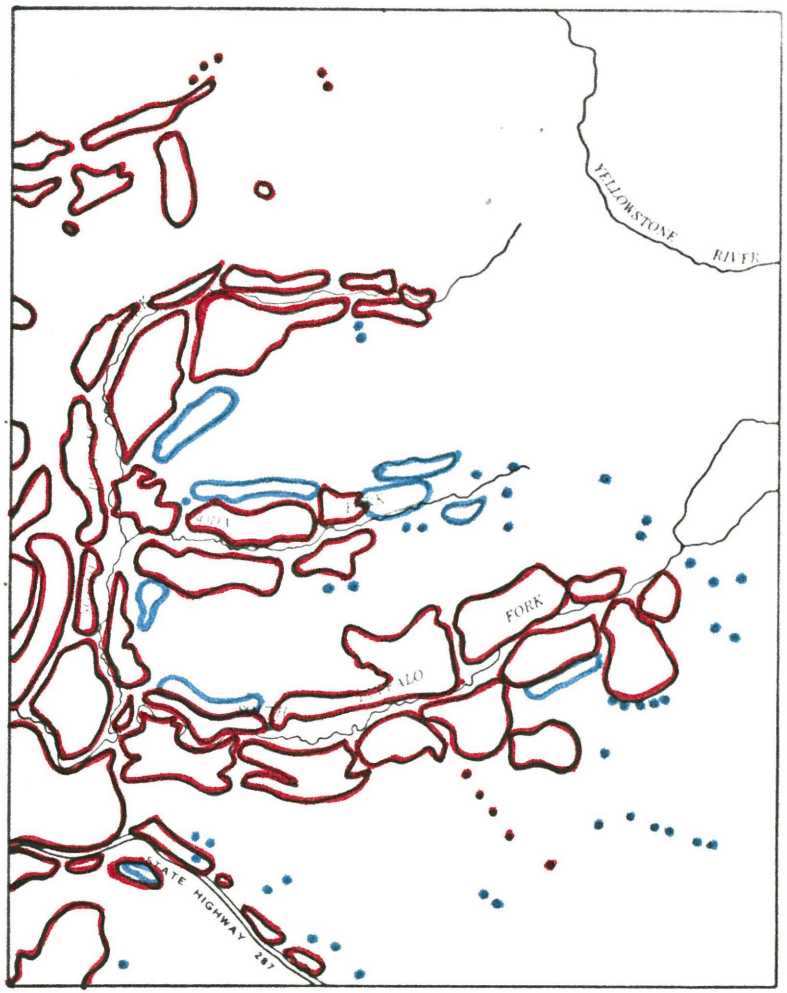
FORK
SODA
FORK
FORK
STATE HIGHWAY 287

1968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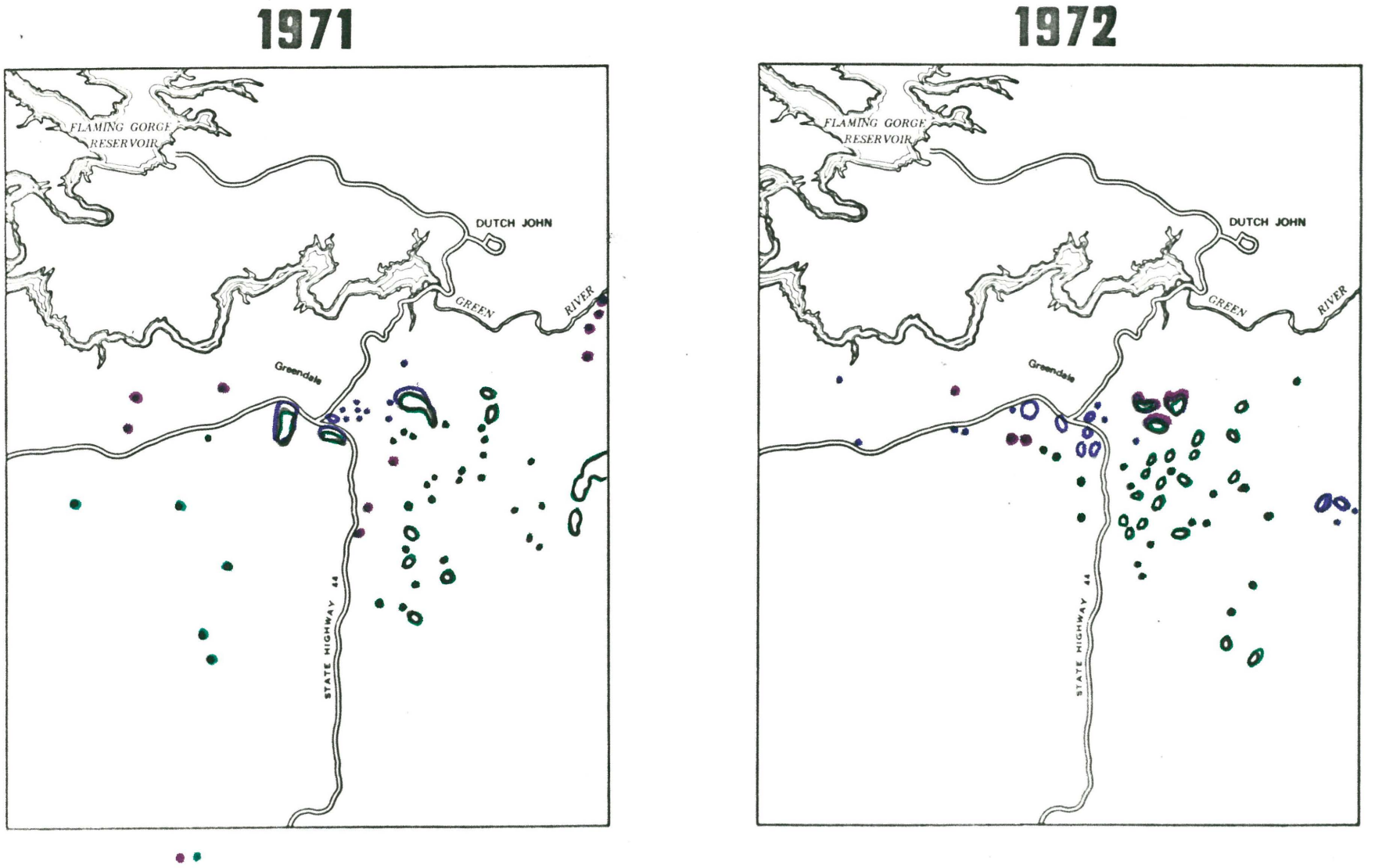
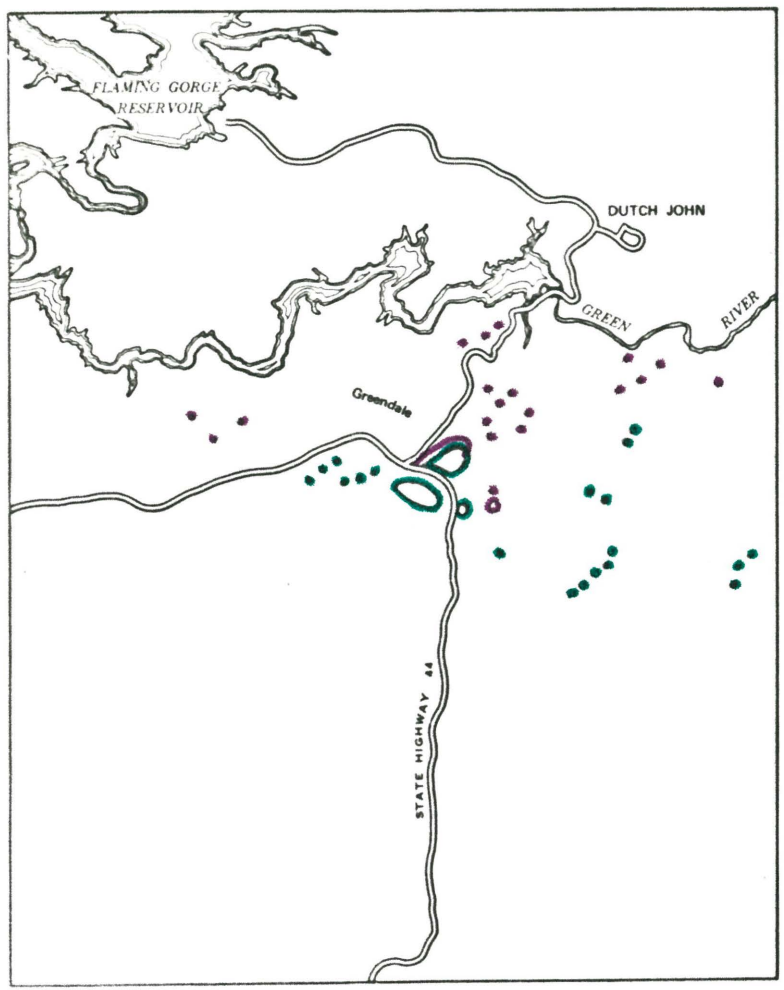


Figure 3. Yearly aerial survey records of the northeastern portion of the Ashley National Forest showing the extent of ponderosa pine (purple) and lodgepole pine (green) mortality caused by *D. ponderosae*. Scale: 1 inch = 4 miles.

1969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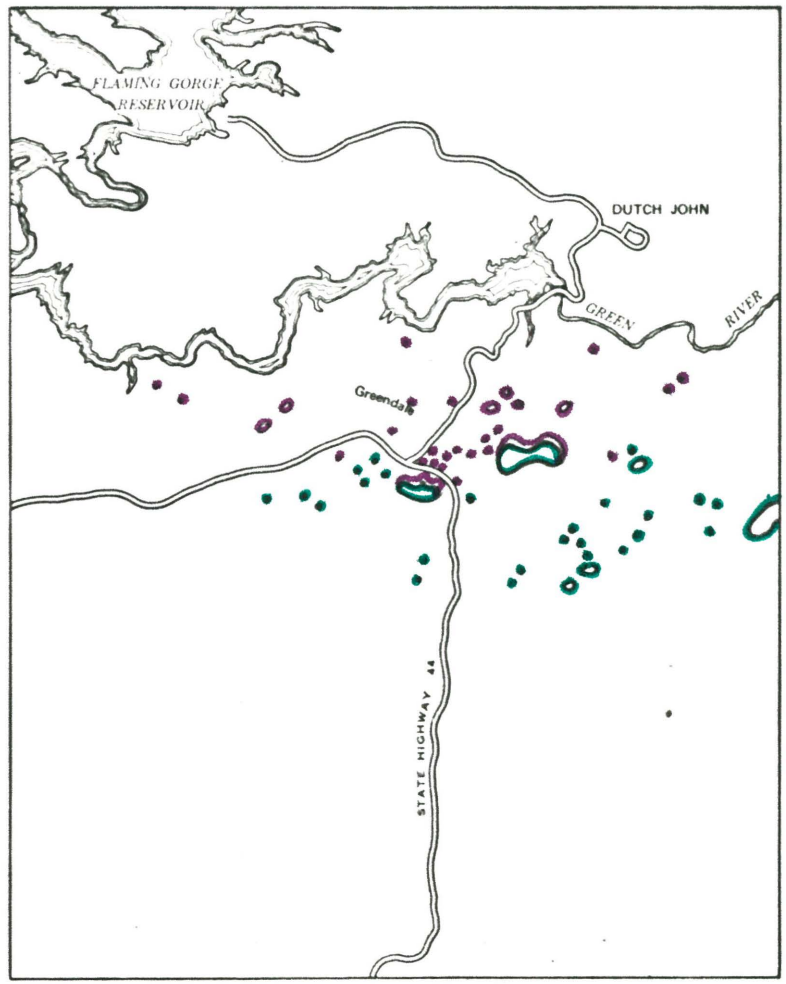
RESERVOIR
DUTCH JOHN
GREEN
RIVER
Greendale
STATE HIGHWAY 44

1970


FLAMING GORGE
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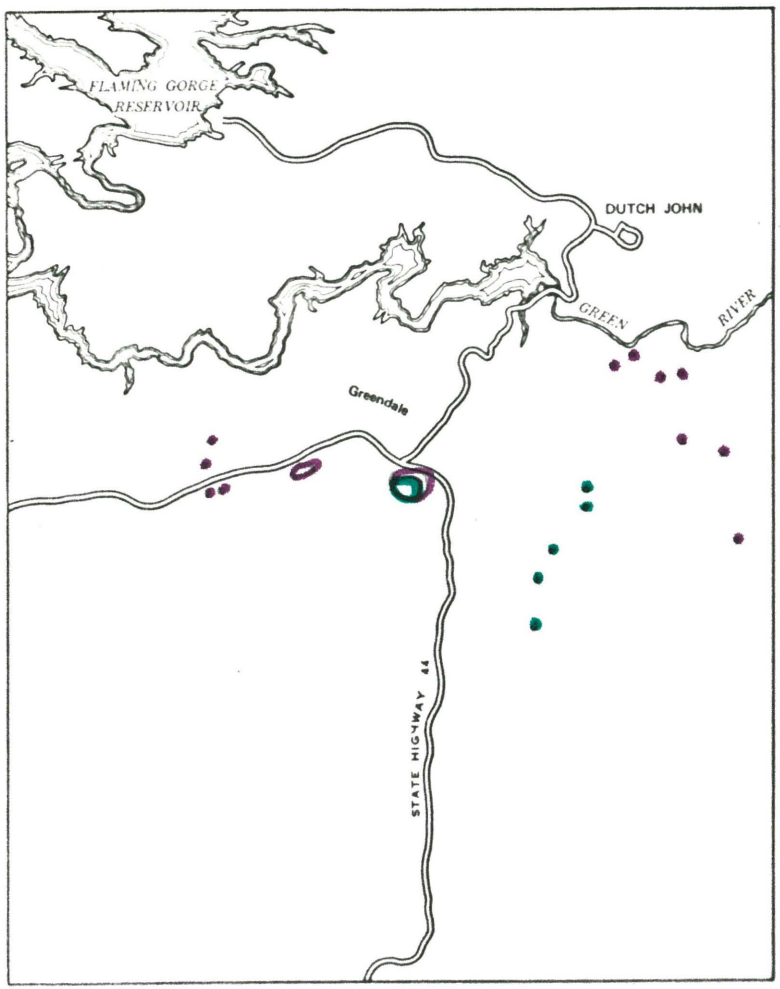
FLAMING GORGE
RESERVOIR
DUTCH JOHN
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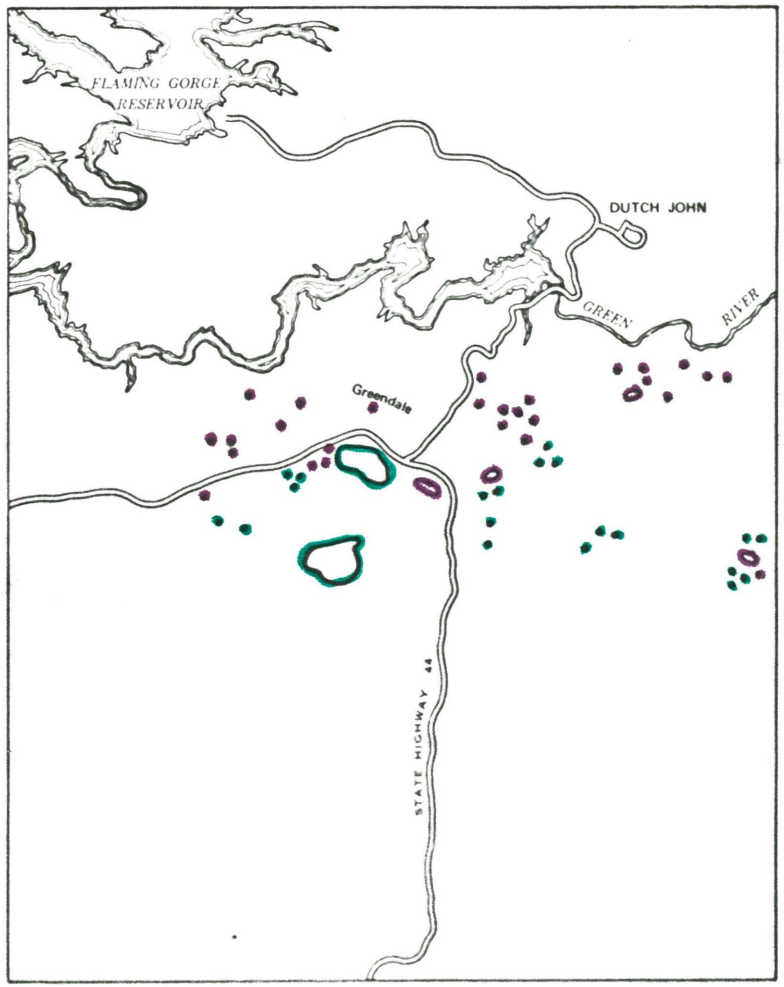
STATE HIGHWAY 44

1968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STATE HIGHWAY 44